SPECIFICATION NUMBER: TS050-02, Rev. -
DATE: 24 October 2003

Purchase Specification
For The
IPS Land Based Test Site

13,200 VAC – 13,800 VAC Transformer (10 / 13.3 MVA)

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1.0 Introduction

This purchase specification and all documents referenced herein contain all of the detailed requirements for (1) Liquid Immersed, Less Flammable Type, 13,200 VAC – 13,800 VAC, 10,000 / 13,300 KVA, 3 Phase, 60 Hz, delta-wye power transformer to be located outdoors at the Naval Surface Warfare Center, Carderock Division, Ship Service Engineering Station (NSWCCD-SSES), Philadelphia Naval Base, Philadelphia, PA. This transformer will be used to supply utility power to a land based test site. It is considered Commercial Off the Shelf (COTS) and could be utilized in various industrial settings, such as heavy manufacturing, requiring substantial utility power.

2.0 Scope

2.1 Equipment and Services to be Provided by the Supplier:

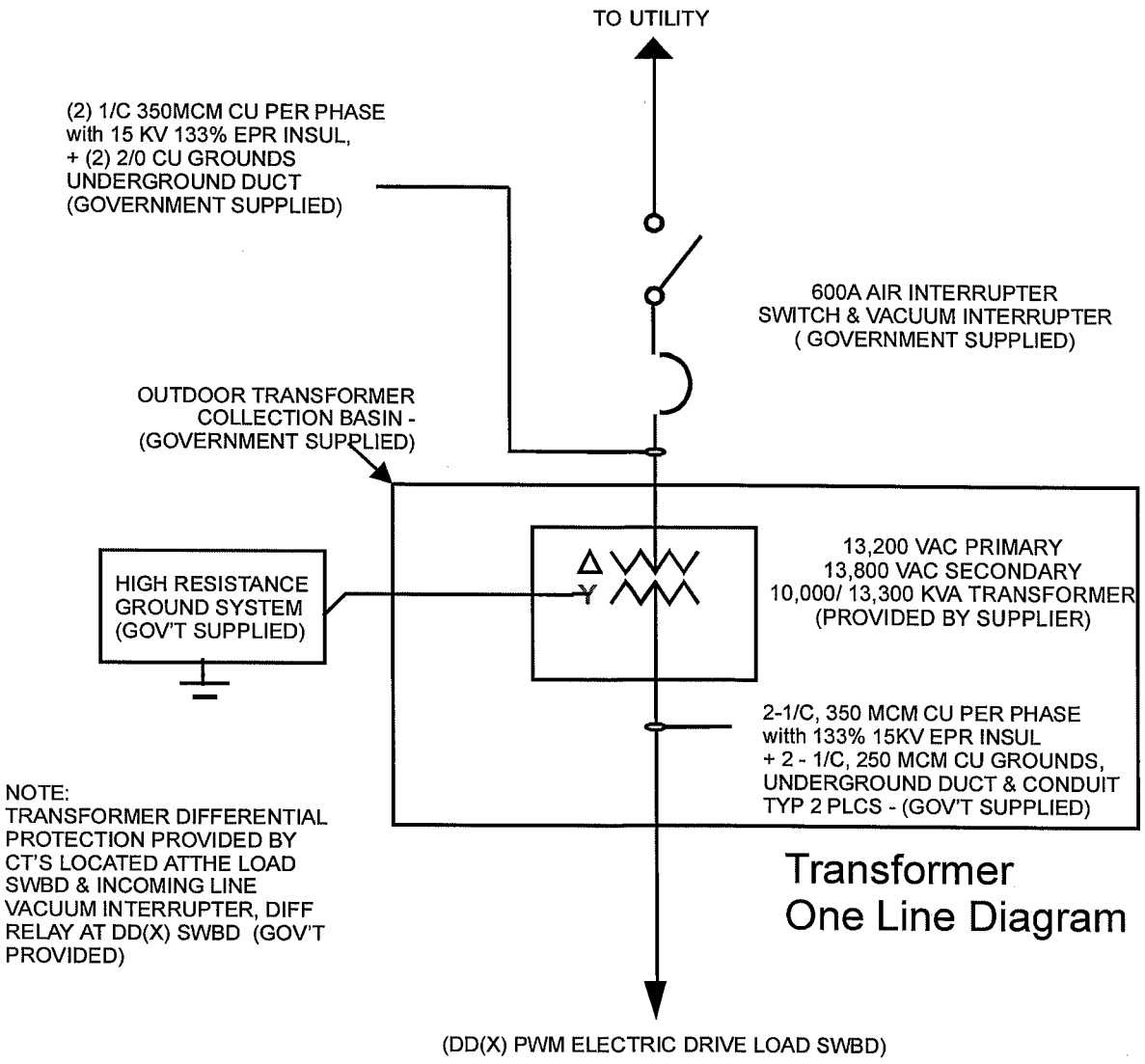
The transformer and protective devices (see Figure 1) shall be suitable for industrial installation and shall be constructed in accordance with the best commercial practices. It shall be the Supplier's responsibility to furnish equipment suitable and complete in details for the services intended. The equipment shall be designed, constructed and tested in accordance with applicable regulations of IEEE, Underwriter Laboratories, Inc., NEMA and the National Electrical Code as specified herein. The Supplier shall be responsible for delivery of each of the following to NSWCCD-SSES in Philadelphia:

Item	Qty	Description
1	1	Transformer, 13,200 VAC – 13,800 VAC, 10,000 / 13,300 KVA, 3 Phase, 60 Hz, Liquid Immersed, Less Flammable Type , Outdoor Primary Unit Substation Transformer
2	1	Release for Manufacture Documentation (Section 4.0)
3	3	Technical Manual (Section 6.2)

2.2 Equipment and Services to be Provided by the Government:

The Government shall install the Transformer and shall be responsible for the following items:

1. Mounting foundations, structural components and mounting bolts attaching the Supplier-furnished equipment to the site structure, and,
2. Associated cabling.


TO UTILITY
(2) 1/C 350MCM CU PER PHASE
with 15 KV 133% EPR INSUL,
+ (2) 2/0 CU GROUNDS
UNDERGROUND DUCT
(GOVERNMENT SUPPLIED)
600A AIR INTERRUPTER
SWITCH & VACUUM INTERRUPTER
(GOVERNMENT SUPPLIED)
OUTDOOR TRANSFORMER
COLLECTION BASIN -
(GOVERNMENT SUPPLIED)
HIGH RESISTANCE
GROUND SYSTEM
(GOV'T SUPPLIED)
13,200 VAC PRIMARY
13,800 VAC SECONDARY
10,000/ 13,300 KVA TRANSFORMER
(PROVIDED BY SUPPLIER)
2-1/C, 350 MCM CU PER PHASE
with 133% 15KV EPR INSUL
+ 2 - 1/C, 250 MCM CU GROUNDS,
UNDERGROUND DUCT & CONDUIT
TYP 2 PLCS - (GOV'T SUPPLIED)
NOTE:
TRANSFORMER DIFFERENTIAL
PROTECTION PROVIDED BY
CT'S LOCATED ATTHE LOAD
SWBD & INCOMING LINE
VACUUM INTERRUPTER, DIFF
RELAY AT DD(X) SWBD (GOV'T
PROVIDED)
Transformer
One Line Diagram
(DD(X) PWM ELECTRIC DRIVE LOAD SWBD)

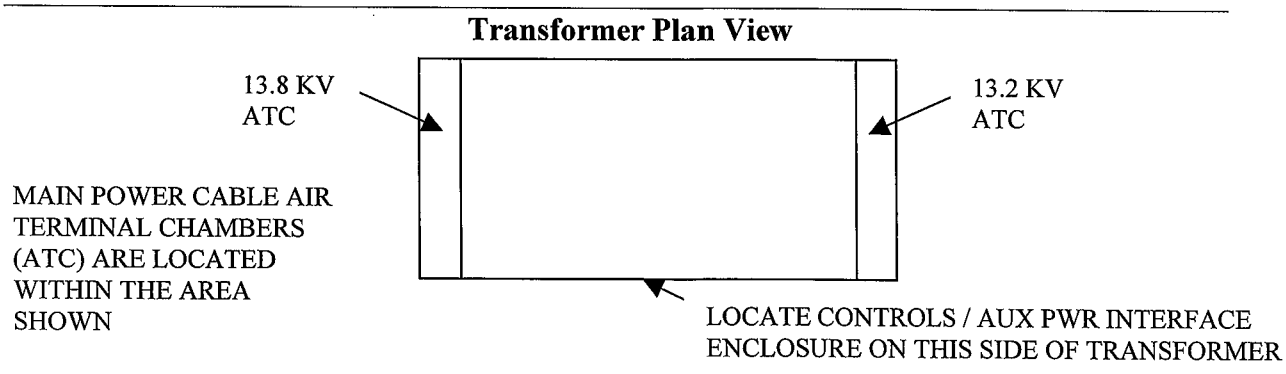

Transformer Plan View
13.8 KV
ATC
13.2 KV
ATC
MAIN POWER CABLE AIR
TERMINAL CHAMBERS
(ATC) ARE LOCATED
WITHIN THE AREA
SHOWN
LOCATE CONTROLS / AUX PWR INTERFACE
ENCLOSURE ON THIS SIDE OF TRANSFORMER

Figure 1

3.0 Applicable Documents

- NFPA-70, National Electrical Code, 2002; Article 450, Transformers and Transformer Vaults
- IEEE Standard C57.12.90-1999, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers
- IEEE Standard C57.12.00-2000, Standard General Requirements for Liquid Immersed Distribution, Power, and Regulating Transformers
- IEEE Standard C57.110-1998, Recommended Practice for Establishing Transformer Capability When Supplying Non-sinusoidal Load Currents

4.0 Release for Manufacture

The Supplier shall submit the following documents to the Government, for approval, prior to obtaining a Release for Manufacture:

- Final Outline, Detail, and Electrical Drawings (Section 6.1)
- List of Special Tools / Equipment required to put transformer in service

5.0 Technical Requirements

5.1 Transformer

5.1.1 General:

A. Transformer Type:	1. Liquid Immersed, Less Flammable Type, Self-Cooled / Fan Forced Air Cooled (KNAN/KNAF) 2. Outdoor Primary Unit Substation Transformer
B. Power Rating:	1. 10,000 / 13,300 KVA continuous at the fundamental 60 HZ frequency. 2. This transformer will be installed in a power system with a large Variable Speed Motor Drive that will inject current harmonics through the transformer. For the transformer proposed, verify that the standard 10,000 / 13,300 KVA transformer is capable of supporting a harmonic load (as specified below) with the inherent margin provided with the Forced Air cooling. The worst case harmonic current profile on a 10 MVA base is specified below: Fundamental = 1pu, 5th = .2152 pu, 7th = .0734 pu, 11th = .0612 pu, 13th = .0389 pu, 17th = .0259 pu, 19th = .0209 pu, 23rd = .0101 pu, 25th = .0094 pu.
C. Temperature Ratings:	1. Designed for 30°C average ambient and 40°C maximum ambient. Transformer shall have a 65° C rise with a minimum 120° C electrical insulation system.
D. Primary Voltage (Source):	1. 13,200 VAC (Delta)
E. Secondary Voltage (Load):	1. 13,800 VAC (Wye)
F. Phases:	1. 3
G. Phase Relationship:	1. 30° angular displacement with source voltage leading the load voltage
H. Frequency:	1. 60 Hz
I. Winding Configuration:	1. Delta-Wye, with full voltage rated neutral wye connection point available for Government connection of high resistance grounding system.
J. Shielding:	1. An Electrostatic Shield is required between primary and secondary windings.
K. BIL:	1. 13.2KV Winding: 95 kV 2. 13.8KV Winding: 95KV

L.	**Primary Taps & Tap Changer:**	1. The following full capacity taps shall be provided: Nominal, +2½ %, +5%, -2½ %, -5%. 2. The de-energized tap changer shall have an external operating handle, tap position indicator, and a position locking mechanism which can be pad locked.
M.	**Impedance:**	1. 5.75% plus or minus 7.5% tolerance. 2. X/R ratio shall be less than or equal to 20.
N.	**Zero Sequence Impedance:**	1. Shall not be less than positive sequence impedance.
O.	**Magnetizing Inrush Current:**	1. Worst case RMS inrush current including DC offset on the 13.2KV side shall not exceed 10X Full Load Amp Self Cooled Rating of transformer. 2. A time vs current plot shall be provided for inrush current from inception to completion of magnetization. Inrush current profile must be submitted as part of proposal for buyer review.
P.	**Identification:**	1. The transformer shall have a nameplate installed in accordance with the referenced standards.
Q.	**Liquid Insulation System:**	1. Silicone (Fire Point >300°C), High Fire Point Mineral Oil (Fire Point >300°C), or equal is required. 2. Liquid insulation system volume shall not exceed 2200 gallons. 3. Transformer shall be certified as a NON-PCB unit. 4. Cooling Liquid proposed must have a proven history of reliable operation. If cooling liquid has been fielded for less than 3 years, provide data for review as part of the proposal.
R.	**Forced Air Cooling:**	1. Forced air cooling fan(s) shall be rated for (3) phase, 460V operation. Fan control circuits shall utilize 115VAC via seller provided control power transformer. 2. Expected power requirements not to exceed 5 KVA.
S.	**Audible Sound Level:**	1. 68 / 70 decibels maximum (Self cooled / with forced cooling)
T.	**Winding Temperature Sensing:**	1. Transformer winding temperature sensing shall be provided for each phase via thermocouple. 2. Thermocouples shall be wired to a supplied Transformer Winding Temperature Monitor. 3. At least (1) spare thermocouple shall be provided for each winding. 4. Local indication and a normally closed alarm contact (contact open to alarm) for transformer remote over temperature alarm shall be provided. The alarm contact shall also go open (alarm) for loss of monitor

	control power. 5. The temperature monitor shall be powered via the buyer supplied auxiliary power supply circuit (460vac). If Temperature Monitor requires other than 460V, it shall be derived from the 460V auxiliary power supply circuit via seller provided equipment.
U. Protection Relay:	1. A Sudden Pressure Relay or equal shall be provided with a normally open dry contact (contact close on tank pressure increase) to interface with a 13.8KV circuit breaker trip control circuit that is rated for use at 120VAC/120VDC/48VDC.
V. Other Required Local Monitoring Devices:	1. Dial Type Top Oil Thermometer 2. Liquid Level Gauge 3. Pressure Relief Device with Semaphore 4. Tap Changer Position Indicator 5. Pressure Vacuum Gauge
W. Surge Arrestors:	1. Provide transformer with distribution type arrestors on the 13.2KV side of transformer. Arrestors shall have a MCOV of 18KV and shall protect against line transients and possible voltage surge caused by upstream vacuum interrupter.
X. Maximum Footprint to Transformer Extremities:	1. 165" x 130"

5.1.2 Enclosure:

A. Enclosure Type / Tank:	1. Outdoor Operation 2. The transformer shall be operable at the ratings given in this specification under humidity conditions between 0 % and 100 % and with air temperature up to 40°C and with the average air temperature for any 24 hour period not to exceed 30°C. 3. There shall be no exposed live parts that can create a shock hazard if touched. 4. 15 PSI minimum tank design is required with formed base, jacking and rolling provisions. 5. Lifting eyes shall be provided. 6. Stainless steel ground pads shall be provided along at least two lower opposite sides of tank. 7. All gaskets shall be fully compatible with the liquid insulating medium provided. 8. Radiator must have vent and drain plugs.

	9. Radiators shall have all seams welded. 10. Radiators shall have isolation valves and shall be removable via bolted flange in case they must be replaced or repaired. 11. An insulating liquid preservation system shall be provided.
B. Tank Fittings:	1. 2" drain valve with 3/8" sampler valve, 2. 1" upper filter press valve.
C. Line Side (13.2KV) Terminations	1. The bushing terminations shall have a silver plated copper connection area to accept (6) 1/C, 350 MCM copper, 15kV, Shielded, EPR insulation, CPE or PVC jacket, 133% insulation level cables and (2) bare 2/0 copper cables (Two conductors per phase and two ground conductors). 2. Terminations shall be rated at 90 degrees C minimum. 3. Terminations shall accept standard NEMA two hole compression lugs with ½" hardware.
D. Load Side (13.8KV) Terminations:	1. The bushing terminations shall have a silver plated copper connection area to accept (12) 1/C, 350 MCM copper, 15kV, Shielded, EPR insulation, CPE or PVC jacket, 133% insulation level cables and (4) bare 250 MCM copper cables. (Four conductors per phase and four ground conductors). 2. The neutral shall be provided with a full voltage rated bushing which will be utilized with a high resistance ground system. 3. Terminations shall be rated at 90 degrees C minimum. 4. Terminations shall accept standard NEMA two hole compression lugs with ½" hardware.
E. Cable Entry (Main Power Circuits):	1. An air filled, cable terminal compartment on opposite ends of the transformer shall be provided for the Main Power Circuits shown in Figure 1 and discussed above in Line and Load Side Terminations. 2. One Air Terminal Chamber (ATC) shall accommodate the 13.2KV utility source cables and the other end shall accommodate the 13.8KV load cabling. 3. Bottom cable entry shall be provided for each ATC.
F. Cable Entry Auxiliary Power / Controls:	1. A separate enclosure from the Main Power Circuit Air Terminal Chambers shall be provided for connection of the Government provided 460 VAC auxiliary power source for the cooling fans and winding temperature monitor. 2. The same enclosure shall also be available for connection of remote alarm and trip circuits (transformer winding temperature high and sudden

	pressure trip circuit). 3. Wiring and conduit between the auxiliary power / controls enclosure and the individual transformer components is the responsibility of the supplier. 4. If any enclosures require heaters to keep components from being degraded from the effects of moisture, they are required to be provided wired with thermostats so they can be powered from the Government provided 460vac auxiliary power source directly or via provided transformers.
G. Paint:	1. Manufacturer's standard, applied over properly prepared surface. 2. The color shall be light gray ANSI No. 61 outdoor with at least a 3 mil thickness.
H. Ground Bus:	1. A ground bus/ ground pad shall be provided in each air terminal chamber as well as along the exterior of at least two opposite sides of the transformer.
I. Shipping Configuration:	1. Ship transformer oil filled and under pressure. Bushings and radiators should also be installed unless they challenge safe delivery.

5.1.3 Testing:

The certified test report for the specified transformer shall include the following tests.

A. Winding Resistance:	IEEE C57.12.90, Section 5 To be performed on all taps.
B. Polarity and Phase Relation Tests:	IEEE C57.12.90, Section 6
C. Ratio Tests:	IEEE C57.12.90, Section 7
D. No Load Losses and Excitation Current:	IEEE C57.12.90, Section 8
E. Impedance Voltage and Load Losses: **F. Zero Sequence Impedance:**	IEEE C57.12.90, Section 9 Note: Test Data of nominal tap and tap extremes is required. Tap extreme testing can be waived if vendor can provide previous test data from another transformer with the same design. Zero sequence impedance testing is included in case transformer is utilized in the future with a solidly grounded neutral in lieu of resistance grounded neutral.
G. Winding Insulation Resistance :	IEEE C57.12.90, Section 10

H. Core Insulation Resistance:	IEEE C57.12.90, Section 10
I. Insulation Power Factor:	IEEE C57.12.90, Section 10
Dielectric Tests: **J. Impulse** **K. Applied Voltage** **L. Induced Voltage** **M. Partial Discharge**	IEEE C57.12.90, Section 10 Note: Impulse Test can be waived if vendor can provide test data from a similarly designed unit.
N. Temperature Tests:	IEEE C57.12.90, Section 11
O. Audible Sound Level Measurements:	IEEE C57.12.90, Section 13 Note: Sound Level Test can be waived if vendor can provide test data from a similarly designed unit.
P. 3 Phase Capacitance to Ground of 13.8KV Winding:	Provide test data or calculation.
Mechanical Tests: **Q. Lifting & Moving Devices** **R. Pressure** **S. Leak**	Note: Lifting & moving devices and pressure test can be waived if vendor can provide test data from a similarly designed unit.
T. Operation Test:	All auxiliary devices such as fans, temperature monitors, sudden pressure relay, etc. must be tested to show proper operation.
U. Dissolved Gases Test:	Transformer liquid must be sampled after energized testing but prior to shipping to obtain baseline data.

6.0 Technical Data

6.1 Drawings

Final Outline, Detail, and Electrical Drawings are required to include the following information: mounting dimensions, rigging features, space limitations, location of center of gravity and transformer weight with and without liquid, cooling liquid name and quantity, customer interface locations, electrical schematics, wiring diagrams, nameplate data, and inrush current time vs current plot. The Drawings shall be included in the

Technical Manual (6.2). The Government will also approve the Suppliers Drawings to provide a Release for Manufacture.

6.2 Technical Manuals

Three sets of technical manuals shall be forwarded not later than the delivery date of the equipment. Technical manuals shall consist of various technical data including: Drawings (6.1), Special Tools / Equipment (6.3), Recommended Maintenance (6.4), Transformer Certified Test Report (5.13), and any other technical information required to install, operate, or maintain the transformer or its accessories.

6.3 Special Tools / Equipment

A list of special tools / equipment required to put transformer in service shall be provided for Release to Manufacture and shall also be included in the Technical Manual.

6.4 Recommended Maintenance

Recommendations shall be provided on the maintenance to be performed and the frequency of maintenance actions for the equipment specified in this document. Also, a recommended spare parts list with pricing shall be included with the maintenance recommendations. This information shall be provided in the Technical Manual not later than the delivery date of the equipment.

7.0 Inspection and Testing

Testing of the equipment shall be performed by the Supplier as specified in Section 5.1.3. The Government reserves the right to witness Supplier testing and to perform equipment inspections where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

8.0 Shipping

8.1 Packaging

Equipment shall be packed for shipping in a manner that will ensure acceptance and safe delivery at destination. Supplier is responsible for damage during shipment.

8.2 Marking

Each package shall be marked with the Contract Number, Contract Item Number and Purchase Specification Number TS050-02.

8.3 Delivery

The articles to be furnished shall be delivered in accordance with the following:

Item 0001 & 0003: Within 112 days after date of order.
Item 0002: Within 21 days after date of order.

Note: The Government shall review and approve, conditionally approve or disapprove the Documentation furnished under item 0002 within 14 days after receipt or within 35 days after date of order, whichever occurs last.

Items 0001, 0002, & 0003 shall be delivered to:

Naval Surface Warfare Center, Carderock Division
Naval Business Center, Bldg 542
Philadelphia, PA 19112-5083
Attn: Mr. Ed Harvey, Code 934